



Double internal combustion piston engine

Zbyszko Kazimierski^a, Jerzy Wojewoda^{b,*}

^aTechnical University of Łódź, Institute of Turbomachinery, 219/223 Wólczańska Str., 93-005 Łódź, Poland

^bTechnical University of Lodz, Division of Dynamics, Stefanowskiego 1/15, 90-924 Lodz, Poland

ARTICLE INFO

Article history:

Received 12 May 2010

Received in revised form 9 October 2010

Accepted 25 October 2010

Available online 26 November 2010

Keywords:

IC piston engine

Sealing

Crank-slider mechanism

Double-side piston

ABSTRACT

An old idea of how to increase the internal combustion (IC) piston engine power is presented. Such an engine has a 2-side action piston, which divides a single cylinder into two working parts. In these parts there are two usual 4-stroke engines which constitute one double IC engine, equipped with a slider-crank mechanism. The new engine may use bio-fuels as well.

The engine may deliver increased power from more compact size – it is estimated to almost double individual levels of the components. The basic technical problem of this solution is sealing and lubrication of the engine, especially sealing of the power head, which is crossed by a rod of the slider-crank mechanism. This is the reason why such an engine has not been manufactured yet, but a modern level of technology may allow manufacturing the engine. The paper is to remind the old idea of how to increase the engine power and additionally to give some propositions of the engine sealing.

© 2010 Elsevier Ltd. All rights reserved.

1. Introduction

It is widely known that the power generated in 2-stroke engines is greater than that in the 4-stroke type, if the rotation and work delivered by them remain the same.

The first aim of this paper is to describe the old idea and to present the engines which have a 2-side action piston in one cylinder and a slider-crank mechanism.

The proposed engine should deliver nearly twice the power compared to conventional 4-stroke one and its efficiency would be a little bit lower, according to our supposition, about 2–3%, when compared to the efficiency of 4-stroke engines. The reason is the friction caused by the slider. An exact value of the efficiency depends on the type of slider design and can be determined by experiments. The described engine can be either of a compression or of a spark ignition type and is the subject of numerous publications. Some of them in a historical order are [1–4]. The engine configuration is given in the next section and is called a double IC engine.

The basic technical problem of this solution is, however, sealing of the engine parts, especially the part where its piston is coupled to a slider-crank mechanism. This is probably the reason why the double IC engine has not been produced yet, but up-to-date technology may allow for manufacturing one.

The second aim of the paper is a proposition of sealing a rod of the crank-slider mechanism which passes through a power head of the double engine. These issues are presented in the next section.

2. The engine configuration, its power and sealing

A schematic drawing of the engine unit is given in Figs. 1 and 2. The important configuration aspects are presented below. The double IC engine is placed in a single cylinder. The piston P of the engine is characterized by double side action and divides the cylinder into two working parts. In Fig. 1 they are marked by T and B. The parts T and B are created by the piston P and a pair of power heads.

In those parts there are placed two usual 4-stroke engines constituting one double IC engine. The engine is equipped with a slider-crank mechanism M and has a usual crankcase K. The power head of part B is more complicated than that situated in part T. The reason is the rod R crossing the head of the chamber B.

The described engine herein has two identical cams marked as CT and CB and shown in Fig. 1. The cams are shifted with respect to each other along the camshaft, which is not visible here. The starting point of the piston P is situated in the highest position of the part T. This statement is valid for both of the included 4-stroke engines. In the above described situation, a 4-stroke engine placed in part T has one stroke producing the energy. Similarly, a 4-stroke engine is placed in space B. In T and B, the double IC engine has two strokes which produce the energy and the angle between them is 180°. The new engine has the crank-slider mechanism M, which produces additional amount of friction and therefore it delivers at same rotation speed nearly twice the power compared

* Corresponding author. Also at: University of Aberdeen, School of Engineering, Fraser Noble Bldg, Aberdeen, AB24 3UE, UK. Tel.: +44 1224 274176.

E-mail address: J.Wojewoda@abdn.ac.uk (J. Wojewoda).

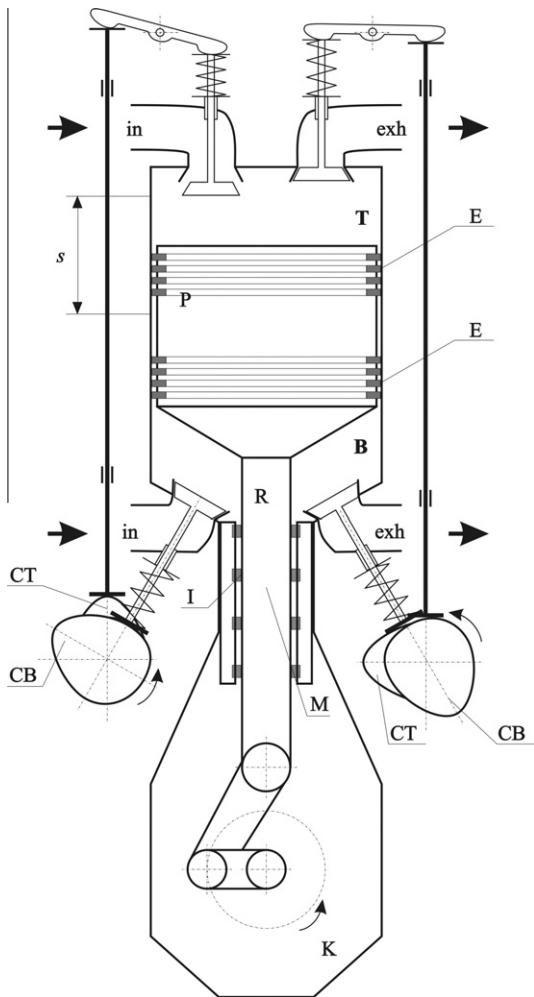


Fig. 1. Schematic view of the double IC engine.

to typical 4-stroke engine while its efficiency is estimated to be a little bit lower. Fig. 1 shows only schematic drawing of the essential unit of the double IC engine. A choice of the solution and detailed design can be made by experienced engineers.

The combustion chamber situated in part B has worse working conditions than the one placed in T. The sealing of the same chamber B is therefore extremely important. This solution may employ experiences gathered during many years of sealing Stirling engines. For example, a rod seal system is explained in [5] as a separate section. It consists of four elements and fulfills the requirement of long life and low leakage rates ($0.1 \text{ cm}^3/\text{min}$) under the high maximum pressure of 20 MPa. The Stirling engine rod sealing may be found as well in [6–8].

Another way is to use the internal surface I of the piston-rings, Fig. 1, where the rod R of the mechanism M is sealed by the rings shown. The rings are lubricated using the rod R. The scraper-ring has to be placed close to the crankcase K where the pressure p_K is lower than the pressure in the space where the rings are placed, Fig. 1.

The next proposition is taken from Fig. 5 of Ref. [1], where the external surface E is taken into account. In this case there exists a tube F rigidly connected with the engine casing (Fig. 2). Between the rod R and the tube F there is a long clearance which links the crankcase K and the empty parts of the piston P. The rod R is coupled with the piston P by a piston-pin N.

Fig. 2 shows the case of sealing B, when the volume of the chamber T is the same as the volume of the chamber B.

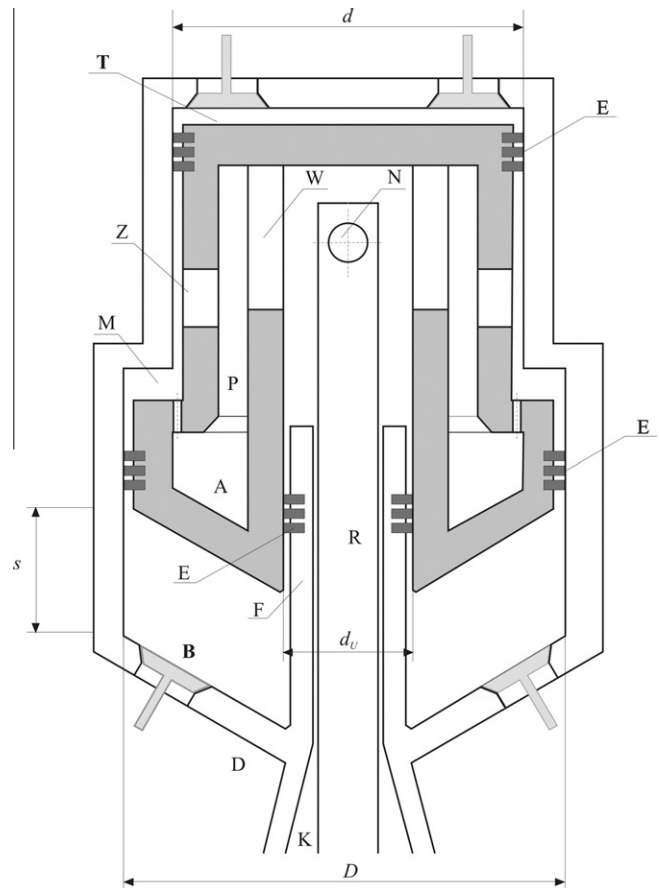


Fig. 2. Schematic view of idea of equal working volumes of the double IC engine.

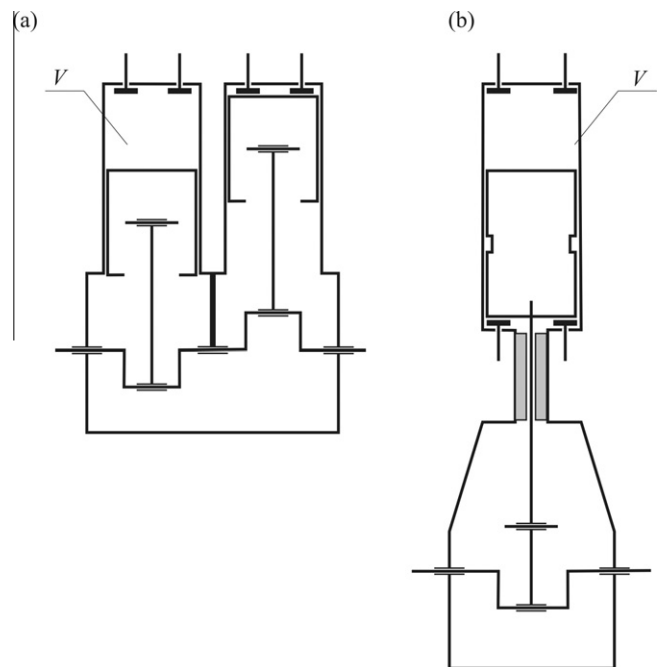


Fig. 3. Comparison of ideas of (a) conventional two cylinder 4-stroke engine and (b) single cylinder double IC engine.

The equality of these chambers requires:

$$D = \sqrt{d^2 + d_0^2}$$

The symbols are explained in Fig. 2. The above formula does not take into account the fact that the efficiency of part B is lower than that of part T. Because of that the diameter D should be a little bit greater than the one calculated above.

The maximal rotation speed of the engine will be established during experiments. It must be close to the speed of the usual 4-stroke engines, i.e., for automotive engines it is about 6000 rpm. Modern level of technology allows for manufacturing such a design. Circulation of the oil in the engine will take place if the pressure in the crankcase K is lower than that in the space where oil is supplied.

3. Conclusions

A double IC engine concept and its sealing have been presented. The engine should deliver nearly twice the amount of power when compared to its single components, i.e., two usual 4-stroke IC engines when they would have the same rpm. The engine may be either of a compression or of a spark ignition type and any fuel suitable for that engine can be used, including bio-fuels as well. The configuration of the engine is given in Section 2.

The idea of the engine is to use the second side of the piston and place the two usual 4-stroke engines on both sides of the piston. This engine is equipped with a slider-crank mechanism. The essential unit of the double IC engine is longer and heavier than one typical 4-stroke engine of the given volume, but in a single cylinder of the double IC engine there are included two 4-stroke engines.

Explained schematically in Fig. 3 are the concepts of (a) two cylinders 4-stroke engine and (b) one single cylinder double IC engine, both of the same working volumes. The efficiency of the

double IC engine with respect to the additional friction caused by a slider is a little bit lower than the conventional 4-stroke solutions, according to our deduction of about 2–3%. The exact value depends on the type of slider and sealing used and can be determined by experimental approach.

The suggested engine may be applied in cars, small planes and helicopters, if the engine unit is not so heavy as two units of the usual 4-stroke IC piston engines, taking into account the volume relations between them and costs of the production and exploitation.

The paper does not violate any patent rights connected with this type of the engine. It only aims to remind how the power of the engine may be increased by a double IC piston engine and to give some propositions of its sealing.

References

- [1] Brown AB. Internal-combustion engine. US patent no. 985,507, February 1911.
- [2] Baer BM. Internal combustion engine. US patent no. 2,317,167, April 1943.
- [3] Montresor G. High efficiency explosion engine with a double acting piston. US patent no. 5,816,202, October 1998.
- [4] Gelfand V. Engine with double sided piston. US patent no. 6,854,429 B2, February 2005.
- [5] Nogawa M et al. In: AIAA Inc., editor. Development of NS30A Stirling engine. The 2nd Research Center of Aisin Seiki Co.; 1987 [Paper 879155].
- [6] Katsuda H et al. Sealing mechanism in stirling engine. US patent no. 5,085,054, February 1992.
- [7] Bergman UC. Sealing devices for stirling engine piston rod in which no separation of oil and gas is necessary. US patent no. 4,146,237, March 1979.
- [8] Bengtsson JI et al. Seal for piston rod of stirling engine. US patent no. 3,848,877, November 1974.